

# FAST HIGH VOLTAGE TRANSISTOR SWITCHES

The high-voltage switches of the model series HTS-SI and HTS-FI have been especially designed for scientific and industrial power pulse applications which require a fast and reproducible switching of peak currents at the kiloampere level. To achieve this, state-of-the-art power semiconductor devices, so-called IGBT's (Insulated Gate Bipolar Transistors) have been employed. These new switching elements of power electronics represent in principal a combination of the classical bipolar transistor with the modern vertical MOSFET. The advantages of both technologies; the current capability and low voltage drop of the bipolar transistor plus the high switching speed of the MOSFET, are ideally combined in the IGBT. By using a hundred or more interconnected IGBT's the switching modules of series HTS-SI/FI achieve the pulse power capability of gas discharge tubes and spark gaps. Additionally, IGBT switches offer advantages like simple connection, short recovery time, low jitter and last but not least the lifetime typical of semiconductor devices.

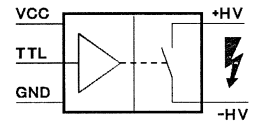
The turn-on rise times of BEHLKE IGBT switches are in practice mainly only limited by the circuit stray inductance. In contrast the turn-off rise times are determined by the bipolar characteristics of the IGBT's. Due to the recombination time of the minority carriers a relatively long turn-off-phase occurs. The turn-off-phase lasts approximately 5  $\mu$ s for the HTS-SI (- Standard IGBT) and approximately 1  $\mu$ s for the HTS-FI (- Fast IGBT) switch. The on-time corresponds to the control signal and can be varied between  $t_{on(min)}$  and infinity. Being galvanically isolated, the devices can be used as high-side switches for positive as well as for negative voltages. The modules are protected against thermal overload, too high a signal frequency, unsuitable control signals, and incompatible auxiliary supplies. For reasons of reliability the devices are completely resin-encapsulated, but in case of failure, a cost-effective repair is possible at factory.

## IMPORTANT!

Do not exceed the rated reverse-blocking voltage, otherwise an undefined breakdown of the switch may occur. If the risk of a current reversal exists (caused by unclamped inductive loads or poor circuit layouts) the switch should be protected by an adequate external diode. For lowest stray inductances the switch should be contacted over the whole width of its terminal blocks. Mounting on a double-sided printed circuit board with 100 mm (4 inch) wide circuit tracks is recommended. In case of pulse transmission an impedance matching between switch, line and load has to be provided. For further design recommendations please refer to the general instructions.

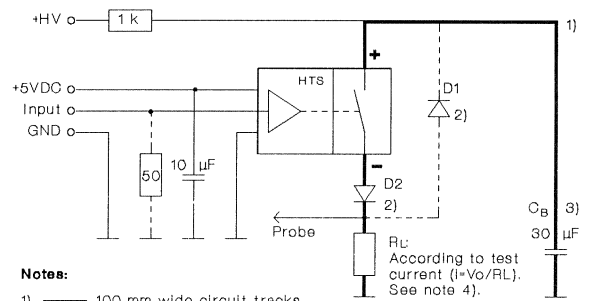
**HTS 51-240-SI** 5 kV, 2.4 kA  
**HTS 51-160-FI** 5 kV, 1.6 kA

- IGBT Technology
- High di/dt Capability
- Full Peak Current Turn-Off Capability



Standard case. Heat sink cases available on request.

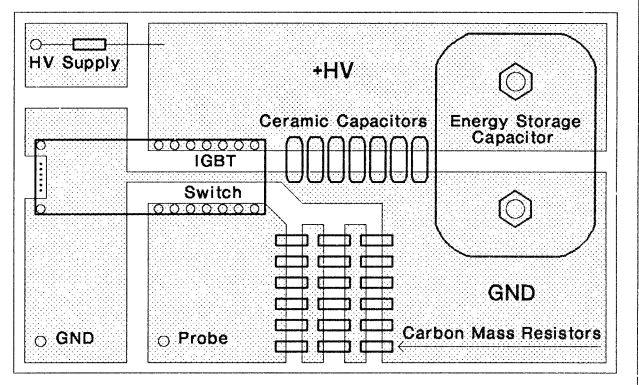
## Test Circuit (High-Side Switch)



### Notes:

- 1) 100 mm wide circuit tracks
- 2) D1/D2 in case of current reversal only
- 3) MAXWELL energy storage capacitor in parallel with 500 nF ceramic cap.
- 4) ALLEN BRADLEY 2 watt mass resistors, > 30 pieces in parallel & series. RL is 2.0 Ohm (-SI) respectively 3.0 Ohm (-FI) for  $I_p(max)$  at  $V_o(max)$ .

## Test Board (Top View)



# TECHNICAL DATA

SPECIFICATION	SYMBOL	CONDITION / COMMENT	51-240-SI	51-160-FI	UNIT
Maximum Operating Voltage	$V_{O(max)}$	$T_{case} = 25^{\circ}C$	$\pm 5000$		VDC
Minimum Operating Voltage	$V_{O(min)}$	Recommended for saturated switching	500		VDC
Breakdown Voltage	$V_{br}$	$I_{off} > 10 \text{ mA}, T_{case} = 25^{\circ}C$	5500		VDC
Temperature Coefficient of $V_{br}$			+ 7.5	+ 6.25	V/ $^{\circ}C$
Max. Reverse Blocking Voltage	$V_{rb}$		150		VDC
Isolation Voltage	$V_i$	Continuously	10000		VDC
Typical Saturation Voltage	$V_{sat}$	$0.1 \times I_{P(max)}, 0.8 \times V_O, T_{case} = 25^{\circ}C$ $1.0 \times I_{P(max)}, 0.8 \times V_O, T_{case} = 25^{\circ}C$	15 100	22 70	VDC
Maximum Peak Current 1)	$I_{P(max)}$	$t_p < 100 \mu s, \text{ duty cycle } < 1\%, T_{case} = 25^{\circ}C$ $t_p < 1 \text{ ms}, \text{ duty cycle } < 1\%, T_{case} = 25^{\circ}C$ $t_p < 100 \mu s, \text{ duty cycle } 50\%, T_{case} = 25^{\circ}C$ $t_p < 1 \text{ s}, \text{ duty cycle } 50\%, T_{case} = 25^{\circ}C$	2400 1500 825 600	1600 1000 550 400	ADC
Maximum Continuous Current	$I_L$	Standard plastic case, $T_{case} = 25^{\circ}C$	3	2	ADC
Maximum Off-State Current	$I_{off}$	$0.8 \times V_O, T_{case} = 25^{\circ}C$	1		mADC
Minimum On-Time	$t_{on(min)}$		1	0.2	$\mu s$
Turn-On Delay Time	$t_{d(on)}$	$0.1 \times I_{P(max)}$	130		ns
Typical Turn-On Rise Time	$t_{r(on)}$	$0.1 \times I_{P(max)}, 0.8 \times V_O$ $1.0 \times I_{P(max)}, 0.8 \times V_O$	50 120	30 80	ns
Typical Turn-Off Rise Time 2)	$t_{r(off)}$	Resistive load	5	0.8	$\mu s$
Typical Turn-On Jitter	$t_{j(on)}$	$V_{tr} = 5VDC, V_{aux} = 5.00 \text{ VDC}$	500		ps
Maximum Burst Frequency 1)	$f_{b(max)}$	(1 / Minimum Pulse Spacing)	0.25	1	MHz
Max. Number of Pulses/Burst 1)	$N_B$	Use burst option for $> 20$ pulses / $100 \mu s$	20		
Max. Continuous Frequency 1)	$f_{c(max)}$		1	6	kHZ
Max. Cont. Power Dissipation	$P_{d(max)}$	Increased $P_{d(max)}$ on request	20		Watts
Linear Temp. Derating of $P_{d(max)}$		$T_{case} > 25^{\circ}C$	0.44		W/ $^{\circ}C$
Temperature Range	$T_O$	Extended temperature range on request	-30...+70		$^{\circ}C$
Switch Natural Capacitance	$C_N$	Capacitance between switch poles	420	250	pF
Coupling Capacitance	$C_C$	Between power and control part	30		pF
Auxiliary Supply Voltage	$V_{aux}$	Maximum tolerance $\pm 5\%$	5		VDC
Auxiliary Supply Current	$I_{aux}$	@ $f_{c(max)}$	400		mADC
Control Voltage	$V_{tr}$	$> 3VDC$ recommended	2-10		VDC
Fault Detection Signal		"Low" in case of fault	High: 4.8 (Typ.)	Low: 0.2	VDC
Dimensions		Case only	199.5 x 76.4 x 25.4		mm <sup>3</sup>
Weight			730		g

- 1) CAUTION: These data have to be considered in conjunction with the maximum continuous power dissipation! Please refer to the general instructions.  
2) Faster turn-off rise times are optionally available at reduced peak current capability. Please consult factory.

